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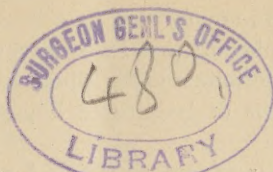
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GALVANISM IN THE TREATMENT OF CORNEAL OPACITIES.

BY L. A. W. ALLEMAN, M.A., M.D.

Cases of corneal opacity are very frequently discouraging ones, alike to the patient and to the physician. It is almost an occasion of reproach to the physician that he should so frequently be unable to afford any relief to a patient who presents an eye, healthy in every particular, and capable of giving the best visual results save for some loss of transparency of corneal tissue, limited perhaps to a superficial layer. To the patient, likewise, a corneal opacity is particularly unfortunate, not only on account of the visual defect, but because it aggressively invites the attention of others to its existence.

Recent corneal opacities will sometimes respond quite readily to treatment, and the reparative power of nature is undoubtedly greatly assisted by stimulating applications, massage, and the like, but we soon reach the limit of our usefulness; and for old opacities, little remains but surgical interference. This is frequently inadvisable, and always unsatisfactory.

Corneal transplantation offers an inviting field, but thus far has accomplished but little. The clearing of the cornea surrounding the transplanted area will, it seems, be more frequently obtained than the permanent transparency of the engrafted tissue. Even were it a more generally successful operation, its utility is limited to those cases in which no benefit can be obtained from an iridectomy, and where the opacity does not extend through the entire thickness of the cornea.

It is impossible to obtain satisfactory statistics as to the frequency of lesions of transparency of the cornea. Having once applied for relief and receiving little encouragement, patients do not drift from one eye clinic to another, consequently the records of these institutions would lead us to infer that such cases are more rare than is actually the case; but when we remember the vast number of cases of keratitis

that we daily see, many of them so severe that they must leave permanent traces of their existence, we are convinced that corneal opacity must be a very common affection.

It is with great pleasure that I present a contribution to the therapeutics of these unfortunate cases, which I believe to be of some real value, and that offers at least some hope of improvement in nearly every case.

The method of treatment to which I refer, is the application of galvanic electricity directly to the surface of the cornea. So extravagant have been the claims of some of the advocates of electrotherapeutics that the profession in general, having been disappointed in their endeavors to justify these statements by their own experience, are inclined to look with great distrust upon any plea for the further extension of this method of treatment.

I have, therefore, endeavored in making the experiments with which I have been for some time engaged, to avoid as far as possible all errors which may arise from careless observation or too vivid imagination on the part of patient or physician.

In testing the vision from time to time I have used artificial illumination of unvarying brilliancy, and, by frequently changing the test-letters, have endeavored to prevent the patient from committing them to memory.

I have measured the vision exactly in each instance, using a steel tape as a measure of distance, to obtain greater accuracy.

When in any case I have used a mydriatic, either to ascertain what vision could be obtained through the clear cornea surrounding the scar when the pupil was dilated, or to better observe the condition of the lens, iris, etc., I have either taken no records of the vision till the effects of the mydriatic have passed away or have indicated in my record that the pupil was dilated at the time the record was made.

During treatment the visual record was always taken before the instillation of cocaine or the application of the current.

The idea of using galvanism for the removal of corneal scars first suggested itself to me from noticing the good results obtained by gynecologists in some cases of old inflammatory deposits in the pelvis. It seemed to me reasonable that a similar absorption of repair-tissue could be brought about in the cornea, and that electricity would prove a most valuable therapeutic agent, could it be so applied as to produce sufficient molecular disturbance in the cloudy area to bring about its absorption, while at the same time it should have no ill effects upon the healthy tissue of the eye.

I concluded that a small electrode applied to the surface of the cornea was indicated, since by this means a current of great density

would be applied directly to the diseased point and since the greatest molecular activity is induced at a point directly in contact with the electrode, the indication of strictly limiting the current's action would be best fulfilled. I apply the other electrode to the cheek, making the path of least resistance through the soft tissues of the face, in order not to bring the intra-cranial organs nor more of the globe than necessary within the circuit. By reference to Fig. 1, the advantage of the small electrode in immediate contact with the cornea may be readily seen. The current is represented as consisting of a certain number of strands, in both instances the same. It is apparent that the current is brought to bear much more directly upon the cloudy area in A than it is in B. (Fig. 1.)

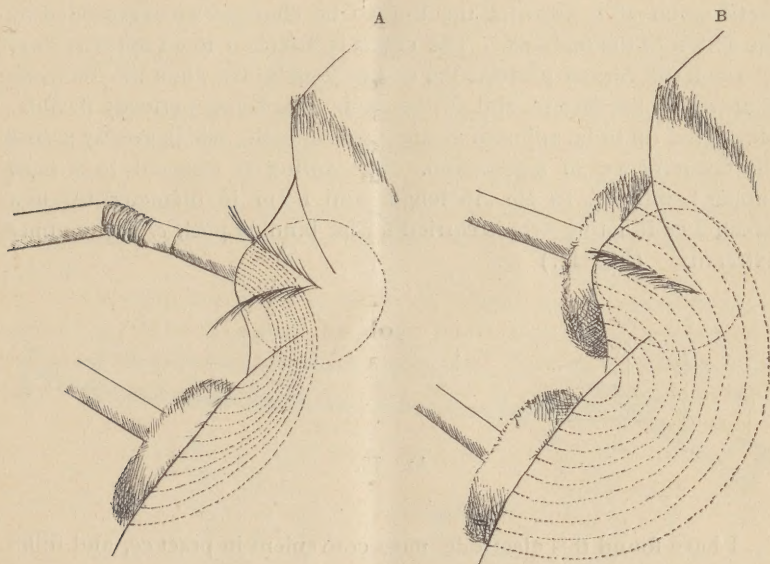


FIG. 1.

It was my original intention to make use of some of the preparations of mercury commonly employed in the treatment of corneal opacities, hoping by the combined action of mercury and electricity to obtain better results than from the use of either agent alone. I made several experiments, usually with the yellow oxide, but found it well nigh impossible to find any vehicle for the mercury which would at the same time act as a good conductor and prove unirritating to the eye. I finally hit upon an expedient which has proved very satisfactory: it was to make the tip of my electrode of silver, which plunged into a bath of metallic mercury, would form with it an amalgam and hold a

globule of mercury on the end of my electrode. This makes a smooth and adjustable cushion to apply to the cornea; it fits itself perfectly to the corneal curve, and precludes the possibility of any unevenness on the surface of the electrode damaging the cornea. Whether or not the mercury in any way assists the action of the current it is quite impossible to say, but be this as it may, it furnishes in practice a most satisfactory tip for the corneal electrode.

After trying various forms of electrodes, I find the most desirable model to be the one shown in Fig. II. It consists of a small silver bar, *a*, 12 mm. in length, insulated, except at the ends, by a hard rubber shell; the exposed surface at the lower extremity is slightly concave, the better to hold the globule of mercury, and is 7 mm. in diameter. The upper extremity carries a thread which screws into a metal collar at *b*, allowing the tips to be changed when corroded by the action of the mercury. The collar is attached to a copper spring, *c*, which still further protects the cornea from injury when the electrode is moved in the fingers, and at the same time being perfectly flexible, allows the tip to be adjusted to any desired angle, which greatly assists the convenience of application. The spring is fastened to a hard rubber handle, *d*, 10 cm. in length and 1 cm. in diameter, through which a conducting wire is carried to the binding post, *e*, at the upper extremity. (Fig. II.)

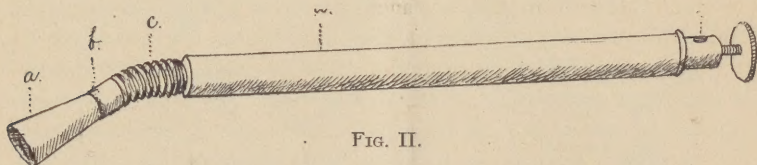


FIG. II.

I have found this electrode most convenient in practice, and fulfilling all the desired indications.

In the immediate application of electricity to the cornea some form of galvanometer is essential. My first few experiments were conducted without one, and I soon became convinced that an accurate measurement of the current was demanded alike for the safety of the patient and to insure the utility of the treatment. For the small current upon an anæsthetized cornea produces no sensation whatever, therefore the patient cannot inform you whether or not the current is passing. Should the battery be reasonably constant and always in repair, an ideal condition scarcely to be hoped for in practice, the resistance in different patients, and even in the same patient at different times, varies so enormously that it is impossible to judge even approximately the

amount of current which the patient is receiving. I have obtained from the same number of cells used, as nearly as I could judge under similar conditions, currents ranging from $\frac{1}{4}$ to 3 m. a.

I am using a milliampèremeter made by Fleming of Philadelphia. This instrument will measure $\frac{1}{4}$ m. a., and has proved extremely satisfactory. Beside a variation of resistance from varying conditions of conductivity at the beginning of an application, we have to take note of the diminution in resistance during the passage of the current. Erbe¹ has experimentally demonstrated this, and the deflection obtained during the continuous passage of the current, by first increasing and then diminishing the number of cells, is shown in the following table :

With 8 cells.. . . . 0° defl.	With 20 cells.....46° defl.
“ 12 “ 6° “	“ 16 “ 40° “
“ 16 “ 28° “	“ 12 “ 34° “
“ 20 “ 42° “	“ 8 “ 26° “
“ 24 “ 50° “	“ 4 “ 12° “

To avoid the annoyance from such variations in resistance, I found it convenient to use a rheostat ; and since, the satisfactory instrument I am at present using is the only one with which I am familiar, sufficiently delicate to be available with the extremely small currents with which these applications are made, a brief description may be of interest.

The rheostat was made by Mr. J. A. Barrett, and depends in principle upon the diminished resistance, under pressure, of a pledget of cotton permeated with powdered graphite. Its construction may be better understood by reference to Fig. III. It consists of a hard rub-

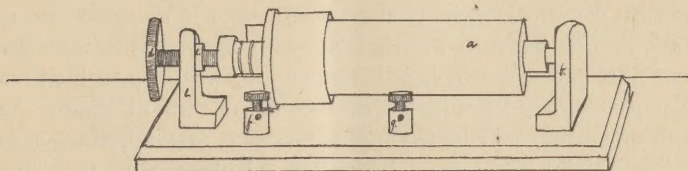


FIG. III.

ber cylinder, *a*, containing the cotton which rests between a metal plate at one end of the cylinder connecting with the post, *b*, and a metal plunger, the rod from which passes through a thread at *c*, and terminates in the milled head *d*. By the rotation of *a* the density of the cotton, and consequently the resistance offered by the rheostat, may be increased or diminished at will. Wires conduct from *b* and *e* to the binding posts *f* and *g*, by which the rheostat is included in the circuit. (Fig. III.)

¹ Electro-Therapeutics, p. 48.

In making an application, I stand behind the patient whose head is thrown back in a reclining chair. I give one electrode to the patient and direct him to press it against the cheek on the same side as the eye to be treated. I then place the binding post of the eye electrode against the patient's tongue and turn the rheostat, until the needle indicates the strength of current I desire to use, when after dipping it in a bath of mercury, I place the electrode upon the cornea, which has been anæsthetized by the previous instillation of cocaine. The rheostat is now intrusted to an assistant, who carefully watches the needle of the milliamperemeter, and by turning the screw of the rheostat, maintains a uniform current during the application. With the thumb and first finger of the left hand the lids are separated sufficiently to prevent their coming in contact with the electrode, since a current easily tolerated by the cornea is painful and irritating when passing through the margin of the lids. The electrode is held with the right hand, gently, in contact with the cornea, and careful watch is kept during the application that the contact is not broken nor too firm a pressure made against the cornea.

It is perhaps unnecessary to test the current by first passing it through the tongue, which offers practically the same resistance as the eye, but as there is always the possibility that by some accident the rheostat or milliamperemeter may be out of order or short-circuited, I think it safer to first try the current upon the tongue, where, if it is too strong, the patient will quickly inform you.

The cathode is applied to the cornea, being theoretically indicated for the stimulation I wish to produce.

The strength of current that may be safely employed varies widely in different cases. I begin treatment with $\frac{1}{4}$ or $\frac{1}{2}$ m. a. for one minute; should this be easily borne, I gradually increase the time up to three or four minutes, which is about as long as it is possible to hold the electrode firmly in contact with the cornea without fatigue. The strength of current may be slightly increased at each application, until the patient's point of tolerance is reached. I place as the limit in any case a current which is followed by a slight irritation, which shall subside before the next application, which I usually make after an interval of one day. The strongest current that I have employed is 4 m. a. for three minutes; but I do not think any better results were obtained by this than by a smaller current repeated at more frequent intervals.

A current of 4 m. a. will only be borne in exceptional cases, and 1 to $1\frac{1}{4}$ will, I think, give the best results. With this current considerable irritation is sometimes experienced at the anode by thin-skinned

people, and I have frequently produced marked vesication on the cheek without setting up any disturbance of the cornea.

During the passage of the current the iris is seen to dilate, even when already somewhat dilated by the action of cocaine.

It is perhaps worthy of note that with the electrode on the cheek, as a rule, no light sensations are observed by the patient during the making or breaking of the current, which I think indicates that the current does not deeply penetrate the eye, because the same current strength through the closed lids with the electrode at some indifferent point does usually excite such sensations.

The following series of cases are some of those upon which I have carried out corneal galvanization during the last year and a half. I have been obliged to omit some cases which have been interesting and instructive to myself when no visual record was obtainable, the patient possessing only l. p., and where I depended for my record of results upon a photograph; such patients having disappeared without giving me an opportunity to obtain a second photograph.

When first recording my cases I endeavored to obtain a record for comparison by measuring the opaque area, but this proved not to be satisfactory. The boundary of the opacity, especially when under treatment, is not well enough defined to allow of accurate measurements being taken.

I have also tabulated all but the longer cases, in order that the duration of treatment, progress, and result may be more readily seen.

CASE I.—E. C., male, aged nineteen. Patient at the N. Y. Eye and Ear Infirmary. Referred to me for treatment by Dr. Mittendorf, on December 13, 1888. The patient had probably suffered, when an infant, from ophthalmia neonotorum, which had left an opacity covering the lower two-thirds of the cornea. The eye deviated upward and inward. His vision in the affected eye was at that time $\frac{2}{200}$. I gave him an application of electricity, the negative pole applied to the cornea, using three cells for one minute. As this application was followed by no reaction, finding on December 15th vision slightly improved, I repeated the application, intending to somewhat increase the strength of the current. The battery had in the meantime been recharged, a fact of which I was uninformed, and I was very much surprised to discover a very peculiar appearance of the eye under the electrode. The secretions in contact with the electrode had been decomposed by the current, and the small bubbles covering the surface of the cornea gave it the appearance of having been severely burned by the electrode.

This very forcibly impressed upon me the danger of using a current in direct contact with the cornea without a milliampèremeter. Fortunately, in this case, no serious harm was done; the cornea had been slightly burned, and became a little more opaque at one point. Some inflammatory reaction followed, which yielded readily to atropine, and the patient's vision very rapidly improved; vision of $\frac{10}{200}$ being obtained. On January 23d, 1889, when the applications were again resumed. By February 9th, vision was improved to $\frac{20}{200}$? After two more applications vision of $\frac{20}{200}$ and J. 9 was obtained, which was not improved by March 16th. I then concluded that the eye was amblyopic, and that no further improvement would be obtained, and treatment was discontinued.

There was a marked improvement in the appearance of the cornea, which, after the inflammation following the second application had subsided, was found to have cleared most remarkably, and continued to improve while under observation.

When last seen very little opacity was visible.

CASE II.—Mrs. M. H., patient at the N. Y. Eye and Ear Infirmary, also referred by Dr. Mittendorf. Three months before, she had suffered from suppurative keratitis. It was then two months since all signs of irritation had disappeared. She had then a slight cloud extending over the lower two-thirds of the cornea; vision = $\frac{20}{200}$. On December 18, 1888, she was given $\frac{1}{2}$ m. a. for one minute. This application was followed by only a very slight reaction. On December 20th, vision = $\frac{20}{100}$; $\frac{1}{2}$ m. a. was given. On December 22d, vision = $\frac{20}{50}$; the application was repeated, but the patient was unwilling to return for treatment, as she lived out of the city, alleging, moreover, that her vision was now sufficiently good for all her requirements. The opacity was much less noticeable than before the treatment was instituted, and the eye had suffered in no way from the application, which fact is of interest, as the case had been one showing lack of nutrition.

I wish here to note that the visual records in Case I., up to January 23d, and in Case II., were made at the N. Y. Eye and Ear Infirmary, without artificial illumination, and that the distances were not accurately measured in each case, as in all subsequent records. The current strength in Case II. and in the first two applications of Case I. have been estimated—no milliampèremeter having been used.

CASE III.—J. M., male, aged thirty-six, suffered from interstitial keratitis some twenty years ago. At present there are corneal opacities of both eyes. The left eye alone was submitted to treatment. This was clouded with a dense opacity extending deeply into the substance

of the cornea. An iridectomy had been performed without benefit: V. = fingers at 18".

On January 15, 1889, treatment was begun with $\frac{1}{4}$ m. a. for one and a half minutes, which was increased up to $\frac{1}{2}$ m. a. for three minutes by January 30th, when, after seven applications, V. = fingers at 54". I then found that with a + 12^D lens, the fellow eye, which had V. = $\frac{10}{200}$, could be greatly improved and so put the same correction on the left, which gave V. = $\frac{5}{200}$. The current was now increased up to $\frac{3}{4}$ m. a. for three minutes, and vision gradually, but only slightly improved, till on the last of February V. = $\frac{10}{200}$ was obtained with the correction. This was after nineteen applications. It was impossible for the patient to take the time necessary to continue the treatment, and it was consequently abandoned.

CASE IV.—Wm. B., aged twenty-eight, presented himself at my clinic at the Long Island College Dispensary, January 19, 1889, giving the following history:

Eighteen years before, while living in Ireland, he suffered from an inflammation of the left eye. Removing to this country while the eye was still inflamed, he presented himself at the N. Y. Eye and Ear Infirmary, where he underwent treatment and an operation. His symptoms were entirely relieved after the trouble had continued for some four months. Since which time the vision of his left eye had been very poor.

In November, 1888, he again visited the Infirmary, at which time I find his vision is recorded as $\frac{20}{200}$ in the left eye. $\frac{10}{200}$ under atropine. (Refraction 5 D. Hm.) He had, when first seen by me, a corneal macula occupying a little more than his pupillary area. His vision at this visit was $\frac{20}{200}$. (This improvement in vision as compared with his record, taken in November, 1888, is probably due to the fact that my test-letters were brightly illuminated.) I began treatment by the application of electricity on January 19th. The patient was phthisical, and it was impossible to use any but the feeblest currents, and even with $\frac{1}{4}$ m. a. I obtained on several occasions very annoying irritation.

I gave him, as a rule, $\frac{1}{4}$ m. a. for two minutes at each sitting, giving him in all ten treatments, vision being improved from $\frac{20}{100}$ to $\frac{20}{40}$. When I last saw him, no cloud could be observed upon the cornea, save by oblique illumination. The patient reported that his vision had been greatly improved by the treatment, and that his left eye was now of the greatest assistance to him in his occupation.

This result is particularly gratifying when we consider the long duration of the opacity.

CASE V.—Mrs. M. M., aged fifty-four; referred by Doctor Mitten-dorf from his clinic at the N. Y. Eye and Ear Infirmary on January 25, 1889. In October, 1888, this patient had suffered from keratitis. All symptoms of irritation had been absent for six weeks at the time she first applied to me; but the scar had diminished only a little, and for some time past there had been no improvement in vision.

Treatment was begun with the application of $\frac{1}{4}$ m. a. for one minute, and at first, under such weak currents, the patient made very encouraging progress. Vision $= \frac{4\frac{1}{2}}{200}$, which the patient possessed at the first treatment, was increased to $\frac{17}{200}$ by the last of February. I then endeavored to use stronger currents, but the result was not encouraging. The treatment was followed by annoying irritation, and had to be discontinued for a time. The patient was very irregular in her visits, and it was therefore not possible by frequent applications of weak currents to keep up the requisite state of stimulation to produce continuous absorption of the opacity.

The last record of vision $= \frac{23}{200}$ on July 5th.

CASE VI.—H. L., female, aged fifty, presented herself at the N. Y. Eye and Ear Infirmary, on January 25, 1889. Some two years before she had suffered from a corneal inflammation in the right eye, of very rapid development, which had at one time reduced V. to l. p. The inflammatory symptoms had subsided after about eight months, and there remained at the time of her first visit a dense white leucoma, entirely covering the lower $\frac{4}{5}$ of the cornea and extending well above the pupil at its maximum dilatation. So dense and complete was the scar that it was quite impossible to determine at this examination whether the pupil was obscured by any inflammatory deposits, although we thought this to be the case, and the margin of the pupil was seen to be very irregular when dilated with atropia.

By throwing the head well forward, V. $= \frac{4\frac{1}{2}}{200}$ could be obtained.

I secured an excellent photograph of this case, and trusted to it as a record for comparison; thinking that there was sufficient loss of transparency back of the cornea to preclude much visual improvement. This case has been most faithful in her attendance, and the result has been extremely satisfactory, but I have, unfortunately, no positive method of indicating the improvement. I have endeavored frequently to obtain a photograph which would show the improvement, but the varying position of the corneal reflection, even in a good photograph, is so confusing, that the photographs are useless as records of results.

I have had this same difficulty in several other cases which I have not included in this report, as I had no means of indicating the improvement obtained.

In this case I gave, as a rule, three applications a week for the first six months, and since that time once a week.

The patient, on her own statement, is much improved. Vision is still about $\frac{6}{200}$, but she can now see with the head erect, the field is much enlarged, and as the fellow-eye is extremely near-sighted, this improvement is a great assistance to the patient. The iris can now be seen through any part of the scar, the density, even in the lower part, which was in the beginning almost as white as the sclera, is greatly lessened, and above, the cloud has entirely disappeared down to about the middle of the pupil. The capsular opacity can be clearly seen, and fully explains the lack of improvement in vision.

The case has progressed but slowly since treatment has been applied but once a week, but I can see that it does improve surely all the time.

CASE VII.—J. Q., male, presented himself at the N. Y. Eye and Ear Infirmary on February 3, 1889. On the 3d of July previous he had been struck in the eye by a piece of coal. An inflammation was set up which lasted for some two months, after which time the eye became quiet and annoyed the patient only by its defective vision. The eye was at this time free from all irritation. Vision $\frac{20}{200}$, with a mydriatic * $\frac{20}{70}$? Patient was referred to me by Dr. Derby for treatment. I gave him $\frac{1}{2}$ m. a. for one minute, and as this produced no disturbance, I repeated it on February 5th. On February 11th, $\frac{1}{2}$ m. a. for two minutes was given. On the 13th, vision was improved to $\frac{20}{100}$ +, and $\frac{1}{2}$ m. a. for three minutes was given; on the 19th, vision = $\frac{20}{70}$? the current at this sitting was increased to $\frac{3}{4}$ m. a. for three minutes. This treatment was repeated on the following day, and on February 25th vision $\frac{20}{50}$ was obtained; $\frac{3}{4}$ m. a. for four minutes was given at this time. The patient subsequently presented himself, but as I was prevented at this time by sickness from seeing him, I lost track of him, and no further record could be obtained.

CASE VIII.—M. J., female, aged sixteen, patient of Dr. Mittendorf, referred by him for treatment, on February 9, 1889. This patient had suffered from an ophthalmia in infancy, which had produced in the right eye an adherent leucoma. The iris was adherent at the lower nasal side, drawing the pupil out to an oblong slit, which was covered by the leucoma, save at the extreme tip, where a little clear pupil was

* Homatropine.

exposed and vision of $\frac{8}{200}$ (as taken by Dr. Mittendorf) was obtained by the patient when looking slightly down. The leucoma was very white and dense at the centre, and extended through the entire thickness of the cornea. The left eye was covered by a still larger leucoma, with closed pupil and only $V. = 1$. p.

I endeavored to get a photograph of the case, but was prevented by the nystagmus which was present.

The vision was $\frac{15}{200}$ when I examined her under atropia. I did not wait till the effects of the atropia had passed away before beginning treatment, so have no record of the near vision till February 23d, when she could see J. 8 at 12". The patient improved quite rapidly at first, and by the last of March had $V. = \frac{20}{200}$. In this case I used stronger currents than in any of the preceding. I began with $\frac{1}{2}$ m. a. for three minutes, and soon increased it to $1\frac{1}{2}$ or 2 m. a. for three to four minutes, but little irritation followed the treatment. The patient was quite regular in attendance till the middle of April, when she informed me she had secured a place at service, her vision now being much improved.

She could see J. 5 at 12", and the leucoma was certainly reduced in size. She had, at this time, had fifteen applications.

After this I saw her at irregular intervals, and vision did not improve any further. I think, however, that the density of the leucoma was still further reduced while under treatment. She disappeared in July, and no further records were obtained.

CASE IX.—M. F., male. On May 14, 1889, patient presented himself at my clinic at the Long Island College Dispensary, giving the following history: Twenty-seven years ago he lost left eye from an injury. Two months before his visit to the dispensary right eye became inflamed and painful. He was treated at the Brooklyn Eye and Ear Infirmary, and made a good recovery. Present condition: Leucoma in right eye, covering the pupillary area. $V. = \frac{6}{200}$, with atropia, $V. \frac{20}{100}$, not improved with glasses. Pupil dilates under atropine irregularly.

He was given 1 m. a. for one minute, and no reaction following, the current was gradually increased, and vision improved by June 8th to $\frac{16}{200}$. The eye which had been somewhat irritated after treatment for a few preceding applications became quite severely inflamed at this time, and treatment had to be suspended. By August 5th vision had improved to $\frac{20}{100}$. Treatment was again resumed, and by August 27th vision of $\frac{20}{70}$ was obtained. Wishing to determine whether or not the treatment was entirely responsible for the improvement, I suspended

treatment from August 27th until October 20th, when I found V. = $\frac{20}{70}$, as on the last visit in August.

Treatment was again for some time discontinued, to be begun again the latter part of February, after six more applications, V. = $\frac{20}{50}$ was obtained March 7th; and after eleven more applications, V. $\frac{20}{40}$? on May 14th.

CASE X.—K. L., aged thirty, female, patient of Dr. Joye at Brooklyn Eye and Ear Infirmary, referred for treatment on May 17, 1889.

In February of preceding year, patient suffered from keratitis in O. S., which lasted for about six weeks, and left a corneal opacity covering the lower two-thirds of the cornea. V. = $\frac{4.4}{200}$, not improved by glasses, with atropia V. = $\frac{20}{200}$. The patient was a phthisical subject, well advanced in the malady, and the general nutrition was very defective.

Treatment began with $\frac{1}{4}$ m. a. for three minutes, which was increased up to $1\frac{1}{4}$ for three minutes. The case never made very encouraging progress. The vision did improve somewhat, being $\frac{10}{200}$ on June 2d, and $\frac{14}{200}$ on July 15th, and $\frac{20}{200}$ on October 9th, after a long interval of rest from treatment. The appearance of the eye was not noticeably improved, except at the lower nasal margin, where an area of clear cornea was visible.

I think the very poor general condition of the patient prevented a more prompt response to treatment. The eye was never very much irritated after treatment, but I was in constant dread of the cornea breaking down and making trouble. The patient's health finally became so poor that I advised her to abandon treatment.

Both the galvanic and faradic currents through the closed lids have, I believe, been employed in the treatment of corneal opacities, but have not thus far commanded the confidence of the profession. From a study of the foregoing cases, I am convinced that when applied directly to the opaque cornea, galvanism becomes a valuable and reasonably reliable method of treatment. I do not believe that I could have obtained equally good results from any other method, and in most of these cases the ordinary methods had been tried without benefit before I instituted treatment by electricity. As will be seen, the rapidity of visual improvement varies much in different cases, and in a large measure depends upon the position of the area of the greatest density of the opacity. The clearing is at first only observable at the periphery of the opacity, and when the scar is concentric with the pupil no improvement in vision is manifest until late in the progress of the treatment. When, however, the pupil is obscured by the less

dense margin of the opacity, most rapid improvement will be obtained from the first few applications.

The age of the opacity seems to have little to do with the rapidity of the improvement under treatment. As will be seen in the foregoing series of cases, which include both very recent and very old opacities, the improvement was as rapid in those which had existed for a long time as in the very recent ones. I would not begin treatment by galvanism till the limit of improvement which would naturally take place had been reached, but as soon as the eye is quiet and no further clearing seems to be taking place, the treatment should be instituted by very weak currents.

My experience with the treatment is not sufficient to warrant me in saying how much we may reasonably expect from it, and what cases we must decline as hopeless. In cases with dense opacities, treatment must be continued for a very long time to accomplish any noticeable results. But in cases I., III. and IV., all cases of long standing, with very dense opacities, there was a steady improvement while under treatment. How long this would have continued it is quite impossible to say. Our knowledge of the action of galvanism, when applied to the living human body, is not by any means as great as we could wish, and it is quite impossible to say at all definitely how it accomplishes the absorption of corneal opacities. It seems to me to be a matter of increased nutrition and of a retrograde metamorphosis of the scar tissue, accomplished by the electrolytic action of the currents. But since when we speak of the different actions of the current, that it is electrolytic in one case, cataphoric in another, etc., it is chiefly a matter of words, the observed phenomena are of much more importance.

After any destructive process in the cornea new material is hastily thrown up to repair the damage, and later on the scar tissue, which is opaque, is replaced by clear tissue. This process will continue till the new tissue becomes so firmly organized as to resist the effects of nature to remove it.

During this process of repair there is a high state of vascularity in the part, and in those cases where vessels are seen running on to the cloudy area, the prognosis is, I think, more favorable. Now, during the application of electricity, this picture is reproduced. The vessels are no doubt dilated by the action of the current. They are seen in great abundance running to the corneal margin or on to the scar. In some cases the scar is seen to be covered during treatment with a fine mesh of vessels, which extend only to the edge of the opacity and disappear with it, as under treatment the clear cornea encroaches upon the scar. After the application the vessels almost immediately disappear,

but I have no doubt that in a less degree the increased vascularity and stimulated nutrition continue for some time, and in treatment I endeavor to keep this process as active as possible without over-stepping the limit and producing a condition of stasis.

CASE I.—DURATION OF OPACITY 18 YEARS.

DATE.	Vision.	Current in m. a.	Duration of Application in minutes.
Dec. 13, '88....	2/200	1/4*	1
Dec. 15, '88....	4/200	1 1/2*	1
Dec. 18, '88....	4/200		
Jan. 23, '89....	10/200	1/4	1
Jan. 25, '89....	9/200	1/4	1 1/2
Jan. 27, '89....	18/200	1/4	1 1/2
Feb. 9, '89....	20/200?		
Feb. 26, '89....	20/200	1/4	2
Mar. 2, '89....	20/200	1/2	2
Mar. 16, '89....	20/200	1/2	2

* Estimated.

CASE II.—DURATION OF OPACITY 2 MONTHS.

DATE.	Vision.	Current in m. a.	Duration of Application in minutes.
Dec. 18, '88....	20/200	1/2*	1
Dec. 20, '88....	20/100	1/2*	1
Dec. 22, '88....	20/50	1/2*	1

* Estimated.

CASE IV.—DURATION OF OPACITY 18 YEARS.

DATE.	Vision.	Current in m. a.	Duration of Application in minutes.
Jan. 19, '89....	20/100	1/4	2
Jan. 21, '89....	20/100+		
Jan. 22, '89....	20/70+	1/4	2
Jan. 26, '89....	20/50?		
Jan. 28, '89....	20/50?		
Feb. 6, '89....	20/50?	1/4	2
Feb. 9, '89....	20/50?	1/4	1
Feb. 13, '89....	20/50?	1/4	1
Feb. 16, '89....	20/50?	1/4	1
Feb. 23, '89....	20/50	1/4	2
Mar. 1, '89....	20/50	1/4	3
Mar. 10, '89....	20/50	1/4	2
Apr. 1, '89....	20/50+	1/4	2
Apr. 5, '89....	20/40?		
Apr. 15, '89....	20/40?		
June 8, '89....	20/40*		

* With and without correcting glass.

CASE V.—DURATION OF OPACITY 6 WEEKS.

DATE.	Vision.	Current in m. a.	Duration of Application in minutes.
Jan. 25, '89....	41/200	1/4	1
Jan. 28, '89....	8/200	1/4	2
Jan. 30, '89....	8/200	1/4	2
Feb. 4, '89....	13/200	1/4	3
Feb. 8, '89....	17/200	1/4	3
Feb. 12, '89....	16/200	3/4	3
Feb. 20, '89....	17/200	1/2	3
Feb. 26, '89....	17/200	1/4	3 1/2
Mar. 27, '89....	17/200	1/4	4
Apr. 1, '89....	17/200	1/2	4
Apr. 11, '89....	20/200	1/4	2
May 2, '89....	20/200	1/4	1
May 20, '89....		1/4	3
May 23, '89....		1/2	4
May 28, '89....	20/200	1/2	4
June 4, '89....		1/2	3
June 6, '89....	20/200	1/2	2
June 10, '89....		3/4	4
June 13, '89....		1/2	2
June 20, '89....		1/2	4
June 27, '89....		1/2	3
July 5, '89....	23/200	1/2	3

CASE VII.—DURATION OF OPACITY 7 MONTHS.

DATE.	Vision.	Current in m. a.	Duration of Application in minutes.
Feb. 3, '89....	20/200	1/2	1
Feb. 5, '89....		1/2	2
Feb. 11, '89....	20/200+	1/2	2
Feb. 13, '89....	20/100+	1/2	3
Feb. 19, '89....	20/70?	3/4	3
Feb. 20, '89....	20/70?	3/4	3
Feb. 25, '89....	20/50	3/4	4

CASE IX.—DURATION OF OPACITY 2 MONTHS.

DATE.	Vision.	Current in m. a.	Duration of Application in minutes.
May 14, '89....	6/200	1	1
May 16, '89....	8/200	1	2
May 18, '89....	10/200	1 1/4	3
May 22, '89....	9/200	1 1/2	3
May 24, '89....	13/200	3/4	3

CASE IX.—DURATION OF OPACITY 2 MONTHS—
Continued.

DATE.	Vision.	Current in a.m.	Duration of Application in minutes.
May 28, '89 ...	14/200	1	3
May 30, '89....	14/200	1½	3
June 4, '89....		1	3
June 8, '89....	16/200	½	2
June 13, '89 ...	16/200	1	3
June 15, '89 ...	18/200	1¼	1
June 18, '89 ..	18/200	2	2
June 21, '89....	20/200	2	2
June 25, '89....	20/200	1	2
June 28, '89 ...	20/200	1	3
July 5, '89....	20/200	1	2
Aug. 5, '89. ...	20/100?	1½	3
Aug. 15, '89 ...	20/100+		
Aug. 27, '89 ...	20/70	1	3
Feb. 17, '90 ...		1	3
Feb. 21, '90 ...		1	2

CASE IX.—DURATION OF OPACITY 2 MONTHS—
Continued.

DATE.	Vision.	Current in m.a.	Duration of Application in minutes.
Feb. 26, '90 . .		¾	3
Mar. 5, '90 ...		1	3
Mar. 7, '90 ...	20/50?	1	3
Mar. 10, '90....		1	3
Mar. 21, '90....	20/50?	1	3
Mar. 26, '90....		1	3
Mar. 31, '90....	20/50?	1	3
April 4, '90....		1	3
April 8, '90....		1	2
April 14, '90 ...		1¼	3
April 28, '90....		1	3
April 30, '90 ...		1	3
May 5, '90....	20/50	1	3
May 11, '90....		1	3
May 14, '90....	20/40?	1	3

